PLANT ECOLOGY OF CEDAR GLADES IN THE BIG BARREN REGION OF KENTUCKY

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The state of Kentucky is located entirely within the Eastern Deciduous Forest Formation, and thus deciduous forests are considered to be the climatic climax vegetation (Braun, 1950). Braun (1950) recognizes two plant associations within the state: the Mixed Mesophytic Forest of the Cumberland Mountains and Plateau and the Western Mesophytic Forest of other physiographic regions of the state.

Prairies or barrens once covered extensive areas of the Mississippian Plateau and the Mississippi Embayment Sections (Loughridge, 1888; Garman, 1925; Dicken, 1935; McInteer, 1942, 1946), and Transeau (1935) included the Kentucky barrens on his map of the Prairie Peninsula. However, these grasslands have, when left undisturbed, reverted to deciduous forests, and it is believed that frequent fires played a major role in maintaining them (Shull, 1921; Sauer, 1927; Dicken, 1935; McInteer, 1946). Dicken (1935) believed that, "The Barrens in Kentucky certainly represented a transition phase of the grassland, not merely from prairie to forest, however, but probably from forest through a temporary grassland back to forest. There can be no reasonable doubt that the Barrens were originally forested." In the Big Barren Region of the Mississippian Plateau there are small areas where the soil is so shallow that, even when left undisturbed, it does not support forest vegetation but instead maintains an herbaceous flora. These openings are surrounded by thickets in which *Juniperus virginiana* L. is an important component and are here referred to as cedar glades. No accounts have been written of the plant ecology of cedar glades within the barren region, and the only cedar glades described in Kentucky are located in Bullitt County, outside the barren region (Baskin & Baskin, 1975).

Within Warren, Simpson, Hart and Logan counties, we have found several small cedar glades (Figure 1) and have prepared a list of the plants occurring on them. The locations for the glades are as follows: (1) Hart County along Rider's Mill Road, 1.6 miles north of state road 728 (north of Priceville), (2) Warren County east of US

31W, 0.2 miles north of the Warren-Simpson County line, (3) Simpson County west of US 31W, 0.4 miles south of the Warren-Simpson County line, (4) Logan County, 0.3 miles south of Dennis and (5) Logan County south of Kentucky state road 100, 2.4 miles east of its intersection with US 68. The Warren and Simpson County glades are developed on Ste. Genevieve limestone, the Logan County glades on Girkin limestone, and the Hart County glades on Reelville limestone. The topography of the glades is mostly flat, and soil depth ranges from 0 to about 25 cm.

A checklist of the herbaceous vascular plants collected on these five cedar glades is given below. Following the name of each species are letters indicating the collection sites: H = Hart Co., W = Warren Co., S = Simpson Co., L-1 = Logan Co. south of Dennis, and L-2 = Logan Co. along Kentucky state road 100. Species which are non-native elements of the flora are indicated by an asterisk. Voucher specimens are on deposit at the University of Kentucky.

CATALOG OF SPECIES

ISOETACEAE

Isoëtes butleri Engelm. W

OPHIOGLOSSACEAE

Ophioglossum engelmannii Prantl S, L-1, W

GRAMINEAE

Andropogon gerardii Vit. S, H
A. scoparius Michx. S, H, L-1, L-2
A. virginicus L. L-1
Aristida longespica Poir. L-1
A. oligantha Michx. S, H, L-1, L-2
A. purpurascens Poir. L-1
Danthonia spicata (L.) Beauv. S
Eragrostis cilianensis (All.) Link.* S
E. spectabilis (Pursh) Steud. S, L-1
Festuca elatior L.* L-2
Hordeum pusillum Nutt. L-1
Panicum capillare L. S, L-1, L-2
P. flexile Scribn. H, L-2

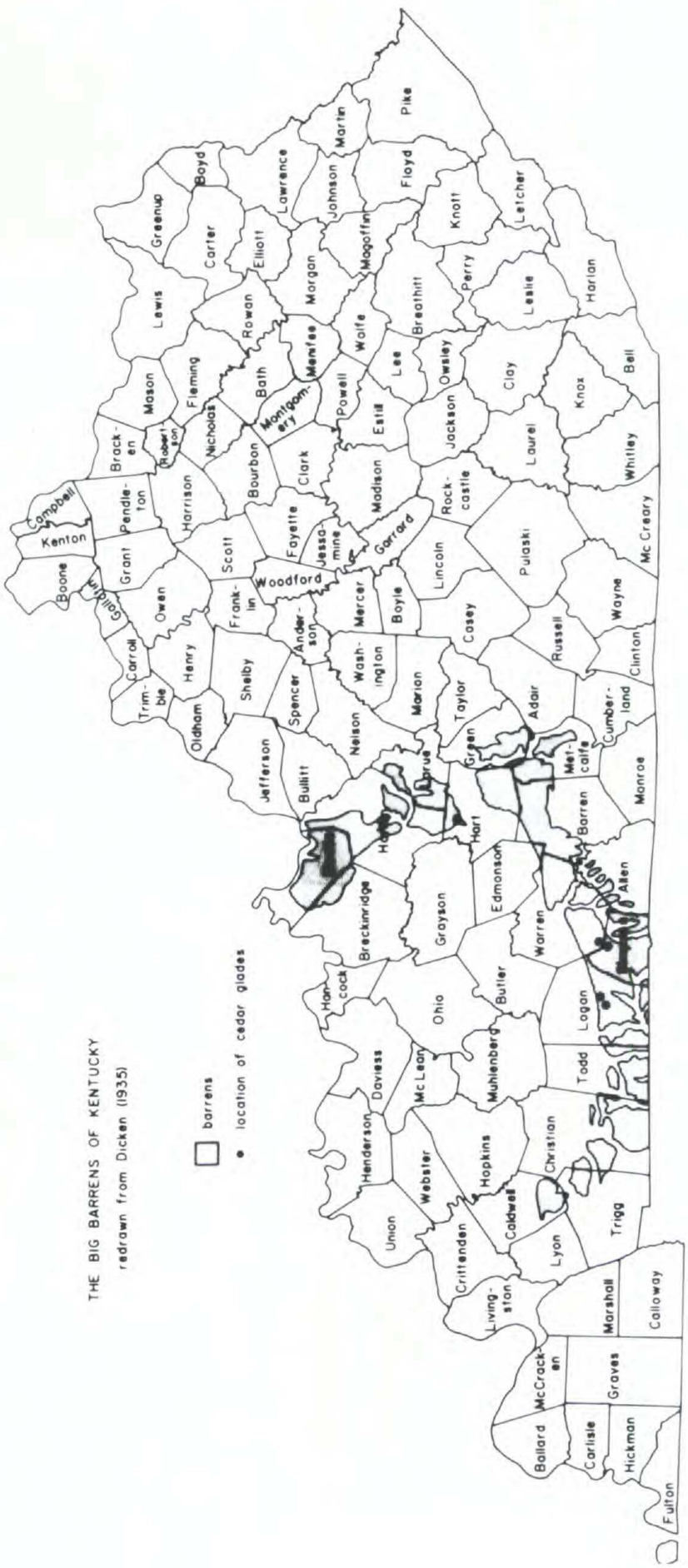

Figure 1. A county map of Kentucky showing the location of cedar glades in the Big Barren Region.

P. lanuginosum Ell. L-1
P. polyanthes Schult. L-1
P. sphaerocarpon Ell. L-1
Paspalum ciliatifolium Michx. L-1
Poa compressa L.* S
Setaria glauca (L.) Beauv.* L-1
Sorghastrum nutans (L.) Nash S, H, L-2
Sporobolus vaginiflorus (Torr.) Wood S, L-1, L-2, W, H
Triodia flava (L.) Smyth S, L-1

CYPERACEAE

Carex complanata Torr. & Hook. S
C. laxiflora Lam. L-1
Cyperus inflexus Muhl. S, L-1, L-2

LILIACEAE

Allium vineale L.* S, L-1, L-2, H
A. cernuum Roth L-2
Nothoscordum bivalve (L.) Britt. S, L-1, W

AMARYLLIDACEAE

Agave virginica L. S, H, L-1, L-2
Hypoxis hirsuta (L.) Coville L-1

IRIDACEAE

Belamcanda chinensis (L.) DC.* L-1
Sisyrinchium albidum Raf. S, H

PORTULACACEAE

Portulaca oleracea L.* S, L-1

CARYOPHYLLACEAE

Arenaria patula Michx. var. *patula* S, H; var. *robusta* (Stey.) Maguire W
Cerastium brachypodum (Engelm.) Robins. S, L-1, L-2
Dianthus armeria L.* L-1
Holosteum umbellatum L.* S, L-1, L-2, W

RANUNCULACEAE

Delphinium virescens Nutt. L-1

CRUCIFERAE

Arabidopsis thaliana (L.) Heynh.* S
Cardamine hirsuta L.* S
Draba verna L.* S, L-1, L-2, W
Leavenworthia torulosa Gray W
L. uniflora (Michx.) Britt. S, L-1, L-2
Lepidium campestre (L.) R. Br.* L-1
L. virginicum L.* L-1

CRASSULACEAE

Sedum pulchellum Michx. S, L-1, L-2, W

ROSACEAE

Potentilla simplex Michx. S, H, L-1
Rosa carolina L. S, H, L-2

LEGUMINOSAE

Baptisia australis (L.) R. Br. L-2
Cassia fasciculata Michx. L-1, L-2
Galactia volubilis (L.) Britt. S, L-1
Lespedeza capitata Michx. H
L. cuneata (Dumont) G. Don* H
L. stipulacea Maxim.* S, L-1, L-2
Melilotus officinalis (L.) Lam.* S, L-1
Petalostemon candidum (Willd.) Michx. L-1, L-2
P. purpureum (Vent.) Rydb. L-2
Strophostyles umbellata (Muhl.) Britt. H
Stylosanthes biflora (L.) BSP. H, L-1

LINACEAE

Linum sulcatum Riddell H, L-2

POLYGALACEAE

Polygala alba Nutt. L-2

OXALIDACEAE

Oxalis violacea L. S, L-1

GERANIACEAE

Geranium carolinianum L. S

EUPHORBIACEAE

Croton capitatus Michx. S, L-1, L-2
C. monanthogynus Michx. S, H, L-1, L-2
Crotonopsis elliptica Willd. L-1
Euphorbia corollata L. H
E. dentata Michx. S, L-1, L-2
E. maculata L. S, L-2
E. supina Raf. S, L-1

MALVACEAE

Sphaeralcea angusta (Gray) Fern. S, L-1

GUTTIFERAE

Hypericum dolabriforme Vent. S, L-1, L-2, H
H. gentianoides (L.) BSP. L-1
H. perforatum L.* L-1

CISTACEAE

Lechea tenuifolia Michx. L-1

VIOLACEAE

Viola rafinesquii Greene S

PASSIFLORACEAE

Passiflora incarnata L. S.

CACTACEAE

Opuntia compressa (Salisb.) Macbr. S, L-1, L-2

ONAGRACEAE

Gaura filipes Spach L-1, H, L-2

UMBELLIFERAE

Aethusa cynapium L.* H
Chaerophyllum tainturieri Hook. S, L-1
Daucus carota L.* S, L-1, H, L-2
Eryngium yuccifolium Michx. H
Zizia aptera (Gray) Fern. H

GENTIANACEAE

Sabatia angularis (L.) Pursh S, H, L-1, L-2

APOCYNACEAE

Apocynum cannabinum L. H.

ASCLEPIADACEAE

Asclepias verticillata L. S, H, L-2
A. viridiflora Raf. S, H

CONVOLVULACEAE

Ipomoea pandurata (L.) G. F. W. Mey. S

BORAGINACEAE

Heliotropium tenellum (Nutt.) Torr. S, H, L-2
Lithospermum canescens (Michx.) Lehm. S

VERBENACEAE

Verbena simplex Lehm. S, L-1, L-2, H

LABIATAE

Hedeoma hispida Pursh L-1
Isanthus brachiatus (L.) BSP. S, H, L-2
Monarda fistulosa L. H

Physostegia virginiana (L.) Benth. H, L-2
Prunella vulgaris L.* L-1, L-2
Pycnanthemum flexuosum (Walt.) BSP. H, L-2
Salvia lyrata L. S, H, L-1, L-2
Scutellaria leonardii Epling H
S. parvula Michx. S, L-1

SOLANACEAE

Physalis heterophylla Nees S
Solanum nigrum L.* S

SCROPHULARIACEAE

Gerardia tenuifolia Vahl L-1, L-2
Leucospora multifida (Michx.) Nutt. S
Penstemon tenuiflorus Pennell S, H, L-1
Veronica peregrina L. L-1

ACANTHACEAE

Ruellia humilis Nutt. S, L-1, L-2, H

PLANTAGINACEAE

Plantago aristida Michx. L-1, L-2
P. lanceolata L.* H, L-1, L-2
P. pusilla Nutt. L-1
P. virginica L. S, L-1, L-2

RUBIACEAE

Diodia teres Walt. S, L-1, H, L-2
Galium pilosum Ait. S
Houstonia lanceolata (Poir.) Britt. S, L-1, L-2
H. patens Ell. L-1

VALERIANACEAE

Valerianella radiata Dufr. S

CAMPANULACEAE

Lobelia spicata Lam. H, L-2
Specularia perfoliata (L.) A. DC. L-1

COMPOSITAE

Achillea millefolium L.* S, L-1
Ambrosia artemisiifolia L. S, H, L-1, L-2
Aster oblongifolius Nutt. H
A. pilosus Willd. S, H, L-1, L-2
Chrysanthemum leucanthemum L.* S, H, L-1, L-2
Cirsium discolor (Muhl.) Spreng. S
Coreopsis tripteris L. H
Echinacea angustifolia DC. H, L-2
Erigeron strigosus Muhl. S, H, L-1
Eupatorium altissimum L. S, H, L-2
E. incarnatum Walt. S
Helenium amarum (Raf.) H. Rock L-2
Helianthus hirsutus Raf. H, S, L-1
H. mollis Lam. L-2
Krigia virginica (L.) Willd. L-2
Kuhnia eupatorioides L. S
Liatris squarrosa (L.) Michx. H, L-1, L-2
L. spicata (L.) Willd. L-2
Parthenium integrifolium L. H
Ratibida pinnata (Vent.) Barnh. H, L-2
Rudbeckia fulgida Ait. H
Silphium terebinthinaceum Jacq. var. *pinnatifidum* (Ell.) Gray L-2
S. trifoliatum L. H, L-2
Solidago nemoralis Ait. H, L-1, L-2
Tragopogon pratensis L.* S
Verbesina virginica L. S

DISCUSSION

A total of 148 taxa, representing 41 families, was collected and all except *Ophioglossum engelmannii* and *Isoëtes butleri* are angiosperms. The two families with the largest number of representatives are the Compositae (26 species) and the Gramineae (22 species).

Characteristic plants of the barrens listed by Garman (1925) that also occurred on the cedar glades are little bluestem (*Andropogon scoparius*), tall bluestem (*A. gerardii*), Indian grass (*Sorghastrum nutans*), white prairie-clover (*Petalostemon candidum*), purple prairie-clover (*P. purpureum*), butterfly-weed (*Asclepias viridiflora*), puccoon (*Lithospermum canescens*), Venus's looking-glass (*Specularia perfoliata*), blazing-star (*Liatris squarrosa*), partridge pea (*Cassia fasciculata*) and button snakeroot (*Eryngium yuccifolium*).

The prairie element in the cedar glade flora is represented by a number of species including *Andropogon gerardii, A. scoparius, Aristida purpurascens, Sorghastrum nutans, Allium cernuum, Delphinium virescens, Baptisia australis, Lespedeza capitata, Petalostemon candidum, P. purpureum, Euphorbia corollata, Gaura filipes, Eryngium yuccifolium, Asclepias verticillata, Lithospermum canescens, Monarda fistulosa, Pycnanthemum flexuosum, Lobelia spicata, Echinacea angustifolia, Kuhnia eupatorioides, Liatris spicata, Ratibida pinnata* and *Silphium terebinthinaceum* var. *pinnatifidum.*

Leavenworthia torulosa was the only cedar glade endemic found in the glades of the barren region. A small population of this species occurs in the Warren County glade. The only other known location for this species in Kentucky is on a small limestone outcrop in Logan County (Baskin & Baskin, 1977).

Of the fifteen characteristic cedar glade species listed by Baskin and Baskin (1975) as occurring in Bullitt County, Kentucky, eleven were collected from cedar glades in the barren region (*Ruellia humilis, Agave virginica, Isanthus brachiatus, Ophioglossum engelmannii, Sporobolus vaginiflorus, Heliotropium tenellum, Scutellaria parvula, Nothoscordum bivalve, Sisyrinchium albidum, Asclepias verticillata* and *Croton monanthogynus*). Other non-weedy species found on the glades in the barren region that frequently are found on cedar glades in the southeastern United States (Baskin, Quarterman & Caudle, 1968; Baskin & Baskin, 1975) are *Isoëtes butleri, Andropogon scoparius, Aristida longespica, Cyperus inflexus, Delphinium virescens, Leavenworthia torulosa, L. uniflora, Sedum pulchellum, Baptisia australis, Oxalis violacea, Arenaria patula, Croton capitatus, Opuntia compressa, Hypericum dolabriforme, Leucospora multifida, Penstemon tenuiflorus,* and *Houstonia lanceolata.* Several of these species also occur on cedar glades in Missouri (Steyermark, 1934).

None of these glades have been left undisturbed which apparently accounts for the large number of weedy species growing on them. All of the glades discussed in this paper, except possible portions of the Hart County glade, have been pastured.

The distribution of plants on a cedar glade is largely determined by soil depth, and zones of vegetation may be distinguished. In the Simpson County glade, which is the largest glade we studied, several relatively distinct zones of vegetation can be recognized. In soils that are from 2–5 cm in depth *Portulaca oleracea, Cyperus inflexus, Euphorbia supina, Sedum pulchellum* and *Leavenworthia uniflora* are the most important species. During summer when the three summer annuals (*E. supina, P. oleracea* and *C. inflexus*) are in the active part of their life cycles, these shallow soils are extremely dry. During late autumn, winter and early spring when the two winter annuals (*S. pulchellum* and *L. uniflora*) are active the soil is moist. In soils 5–10 cm deep *Sporobolus vaginiflorus* is the dominant species. Other plants of some importance in the deeper soils are *Croton monanthogynus, Euphorbia dentata, E. maculata, Panicum capillare* and *Isanthus brachiatus.* These plants are summer annuals and complete their life cycles between spring and autumn. In deep soil (10–20 cm) *Sporobolus vaginiflorus* shares dominance with *Ruellia humilis, Agave virginica, Hypericum dolabriforme, Croton monanthogynus, Heliotropium tenellum* and *Isanthus brachiatus.* Four of these (*S. vaginiflorus, C. monanthogynus, H. tenellum* and *I. brachiatus*) are summer annuals, while *Ruellia humilis, A. virginica* and *H. dolabriforme* are summer-active perennials. In certain areas *Andropogon scoparius* (a summer-active perennial) is the obvious dominant (Figure 2). *Andropogon gerardii* and *Sorghastrum nutans* also occur with *A. scoparius.* Little bluestem does not form a continuous cover but instead occurs in clumps or bunches. *Sporobolus vaginiflorus, Heliotropium tenellum, Agave virginica* and *Ruellia humilis* are the most frequently occurring species in the spaces between the bunches of little bluestem. Soil depths taken in and near clumps of *A. scoparius* ranged from 15 to 25 cm, and in the interclump areas soil depths ranged from 10 to 15 cm. In one small area of the glade, on a gentle slope where the substrate is extremely rocky and soil depths range from 4–8 cm, *Ruellia humilis* is the dominant species. Other species occurring on this rocky slope include *Andropogon scoparius, Sporobolus vagini-*

Figure 2. A portion of the cedar glade in Simpson County, Kentucky dominated by *Andropogon scoparius*. Picture was taken 4 May, 1971.

florus, Heliotropium tenellum and *Aster pilosus*. A few woody plants have become established in small areas where the soil apparently is deeper and/or where there are cracks in the limestone. These species include *Celtis laevigata* Willd., *Forestiera ligustrina* (Michx.) Poir., *Fraxinus americana* L., *Symphoricarpos orbiculatus* Moench, *Rhamnus caroliniana* Walt., *Ulmus alata* Michx., *Juniperus virginiana* L., and *Cercis canadensis* L.

Since many prairie species occur in the cedar glades, we suggest that (1) prairie species may have been present in the glades prior to establishment of the barrens and that the cedar glades served as centers of dispersal of prairie species after the Indians destroyed the forest by burning, or (2) prairie species were not part of the original cedar glade flora and they migrated into the area after the burning of the forests. The cedar glades, along with the few remaining small prairie patches, may be serving as refugia for a once wide-spread prairie flora that existed in the Big Barren Region prior to settlement of the area by European immigrants or their descendants.

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